

REMARKS

By this amendment, applicants have amended claim 1 to recite that the voidage of the secondary particle is 2.5 to 35%. See, e.g., page 11, lines 7-9 of Applicants' specification. Applicants have also added new claims 11-14 to further define their invention. In particular, independent claim 11 is directed to a secondary particle for a positive electrode material comprising a plurality of primary particles composed of crystals having a layer structure of a composite oxide represented by $\text{Li}_a\text{Mn}_x\text{Ni}_y\text{Co}_z\text{O}_2$ where $1 \leq a \leq 1.2$, $0 \leq x \leq 0.65$, $0.35 \leq y < 0.5$, $0 \leq z \leq 0.65$ and $x+y+z=1$, the primary particles being flocculated and linked to form the secondary particle. As set forth in claim 11, the length in which the primary particles are linked on a section of the secondary particle through a substantial center of the secondary particle is equivalent to 10 to 70% of the length of the whole periphery of the primary particles on the section of the secondary particle. See, e.g., original claims 1-5 and, e.g., the disclosure at page 10, line 10 to page 11, line 9 of Applicants' specification. Dependent claims 12-14 define further aspects of the present invention. See, e.g., original claims 3, 6 and 10 and page 11, lines 7-9 of Applicants' specification.

Applicants thank the Examiner for the telephone interview conducted between the Examiner and the undersigned on January 17, 2008. During the interview, the foregoing amendment to claim 1 was discussed. The Examiner indicated the amendment would not be entered after final rejection and that the first office action after the filing of a request for continued examination would not be made final in view of this amendment.

Claims 1, 6 and 10 stand rejected under 35 U.S.C. 103(a) as being unpatentable over JP 2001-85006 in view of WO03/044881. Applicants again traverse this rejection and request reconsideration thereof.

Claims 1 and 6 relate to a positive electrode material and claim 10 to a lithium secondary battery including a positive electrode made of the positive electrode material according to claim 1. The positive electrode material of the present invention includes plural primary particles flocculated to form a secondary particle, wherein the length in which the primary particles are linked on the section of the secondary particle is equivalent to 10 to 70% of the length of the whole periphery of the section of the primary particles. The voidage of the secondary particles is 2.5 to 35%. The secondary particle is represented as $\text{Li}_a\text{Mn}_x\text{Ni}_y\text{Co}_z\text{O}_2$, and the secondary particle is composed of crystals having layer structure of composite oxide meeting $1 \leq a \leq 1.2$, $0 \leq x \leq 0.65$, $0.35 \leq y < 0.5$, $0 \leq z \leq 0.65$ and $x+y+z=1$.

One feature of the present invention is that the “length in which the primary particles are linked on the section of the secondary particle is equivalent to 10 to 70% of the length of the whole periphery on the section of the primary particles.” As described on page 4, lines 1-8 of Applicants’ specification, the ionic conductivity of an electrolytic solution is deteriorated at low temperature. If each secondary particle of positive electrode material is formed with flocculated primary particles and the primary particles are positioned apart from one another so that the spaces among the primary particles are filled with electrolytic solution, a conductive network among the primary particles is locally decreased. Therefore, the resistance increases and the voltage drop of a battery occurs.

On the other hand, by increasing the contact area among primary particles, it is possible to maintain the conductive network in low temperature environment.

Fig. 2 schematically shows that a secondary particle 2 of the positive electrode material is formed with flocculated primary particles 1. For the cross section of each primary particle, the total length of the shared sides with the adjoining primary particles is calculated and compared with the length of the

periphery of the primary particle. The desirable average of such contact length compared with the periphery of the section of the primary particle is 10 to 70%, as presently claimed.

Japanese Patent Publication 2001-85006 (Nakano) discloses a lithium-nickel composite oxide for a lithium secondary battery positive electrode active material and a lithium secondary battery. Generally, a lithium nickel complex oxide changes its particulate structure due to expansion and contraction at charging and discharging. The secondary particle is decomposed into primary particles by repeated charging and discharging. The electron conductivity of the active material decreases and the internal resistance increases to cause the capacity of the lithium secondary battery to decrease.

The Nakano publication does not disclose that a length in which the primary particles are linked on a section of the secondary particle is equivalent to 10 to 70% of the length the periphery on the section of the primary particles. In the Advisory Action mailed November 21, 2007, it is alleged “while an exact percentage may not be possible to determine, in most of the particles shown in Figure, it is clear that at least 10% of the perimeter of each particle is touching another particle.” However, it is not indicated in the Nakano that the drawing is to scale. Since Nakano does not disclose that the drawing is to scale and is silent as to the length in which the primary particles are linked, arguments based on measurement of the drawing features are of little value. *Hockerson-Halberstadt, Inc. v. Avia Group International*, 222 F3d. 951, 956, 55 U.S.P.Q. 2d 1487, 1491 (Fed. Cir. 2000); *Manual of Patent Examining Procedure (MPEP)* 2125. Thus, the Nakano publication does not disclose the recited feature.

Generally, a volume change occurs in the positive electrode material when lithium ions pass into or out from the electrode due to charging and discharging. If

the volume change in the positive electrode material is relatively large and the contact area among the primary particles is increased, the primary particles may be crushed at the contact area due to the volume change, causing the life span of the battery to decrease. Thus, in general, in order to increase the life span of the battery, one of ordinary skill in the art would not increase the contact area of the primary particles. Therefore, it is submitted that it would not have been obvious to one of ordinary skill in the art to make the length of the primary particles are linked on the section of the secondary particle of Nakano equivalent to 10-70% of the length of the whole periphery on the section of the primary particles.

As noted above, Applicants improve the low temperature performance by having a relatively large length in which the primary particles are linked on the section of the secondary particle. However, since, generally, this can adversely affect the volume change in some positive electrode materials, it can be considered that there is a trade-off relation between the low temperature performance the life span of the battery. That is, if the low temperature performance is to be improved, the contact area among the primary particles should be increased, which can cause the life span of the battery to decrease. If the life span of the battery is to be increased, the contact area among the primary particles should be decreased to prevent the primary particles from being crushed, but the low temperature performance is deteriorated.

Applicants, however, achieve good low temperature performance while still decreasing the change of lattice volume due to charging/discharging, thereby not significantly deteriorating the life span of the battery. Applicants accomplish this by, inter alia, having the secondary particle represented as $\text{Li}_a\text{Mn}_x\text{Ni}_y\text{Co}_z\text{O}_2$ and the secondary particle is composed of crystals having layer structure of composite oxide meeting $1 \leq a \leq 1.2$, $0 \leq x \leq 0.65$, $0.35 \leq y < 0.5$, $0 \leq z \leq 0.65$ and $x+y+z=1$. Thus, another

feature of the present invention is that the percentage content of Ni(y) is less than 50%, so that the relative lattice volume change rate decreases. See, e.g., page 15, lines 15-24 of Applicants' specification and Figure 7. As can be seen from Figure 7, the percentage content of Ni is 50% or less, the change of lattice volume due to charging/discharging decreases, therefore, it is possible to maintain the high contact area among the primary particles and a high capacity maintenance rate. Such is not disclosed by Nakano.

In Nakano, the contact area of the primary particles is not disclosed and the content of Ni is less than 50%. Thus, the Nakano publication teaches away from the presently claimed invention.

The Shiozaki publication discloses a positive electrode active material for a lithium secondary cell having a high energy density and excellent in charging/discharging cycle performance, and a lithium secondary cell having a high energy density and excellent in charging/discharging cycle performance are disclosed. A positive electrode active material for a lithium secondary cell is characterized in that the composition of the active material is $\text{Li}_x\text{Mn}_a\text{Ni}_b\text{Co}_c\text{O}_2$ (where a, b, and c are values of a point (a, b, c) on a side of or inside a quadrilateral ABCD having vertexes A(0.5, 0.5, 0), B(0.55, 0.45, 0), C(0.55, 0.15, 0.30), and D(0.15, 0.15, 0.7) on a ternary state diagram showing the relationship among a, b, and c, and satisfy the expressions $0.95 < x/(a+b+c) < 1.35$) and in that the active material contains a composite oxide having an $\alpha\text{-NaFeO}_2$ structure. The lithium secondary cell comprises this active material.

While the Examiner refers to Example 3 in Table 1 of Shiozaki, it is submitted it would not have been obvious to provide the material of Example 3 of Shiozaki as the material of the primary particles of Nakano since the Nakano publication teaches

away from using a nickel content less than 50% in paragraph 0024. Therefore, the presently claimed invention would not have been obvious of Nakano and Shiozaki.

New claims 11-14 are patentable for at least the reasons noted above.

With respect to amended claim 1 and new claim 13, it is noted that another feature of the present invention is that the voidage of the secondary particle 2.5 to 35%. While the Nakano publication discloses that the percentage of voids in the secondary particles is 30% or less, it is noted that the present invention is not characterized solely by the voidage but by the length in which the primary particles are linked on the section on the secondary particle and by the composition, including the nickel content. Such is not disclosed by Nakano and/or Shiozaki.

In view of the foregoing amendments and remarks, favorable reconsideration and allowance of all of the claims now in the application are requested.

To the extent necessary, applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli,

Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (Case: 1021.43559X00),
and please credit any excess fees to such deposit account.

Respectfully submitted,

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